Handbook of Pressure Sensitive Adhesive Technology

Third Edition

Edited by

Donatas Satas

Satas & Associates Warwick, Rhode Island

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Bulk adhesive properties and their measurement is complicated by the viscoelastic character of pressure sensitive adhesives i.e. the dependence of adhesive properties on the rate of force application. Dynamic mechanical analysis allows us to evaluate the viscoelastic behavior of the adhesives and helps to relate it to the adhesive performance. While the consideration of standard adhesive properties dominates the evaluation of pressure sensitive adhesives, the importance of DMA test results has reached a wide and fast growing acceptance as the most informative and promising technique in pressure sensitive adhesive evaluation. Some authors show a clear preference to viscoelastic property description as the main way to discuss the behavior of pressure sensitive adhesives [1].

Storage modulus (G'), loss modulus (G") tan δ (G"/G') and viscosity are the properties obtained by DMA testing. These properties are determined as a function of temperature (temperature sweep at a constant frequency), or as a function of frequency (frequency sweep at a constant temperature). While the range of frequency sweep is limited, the data contains more details and may be preferred for detail property comparison.

EFFECT OF PLASTICIZERS AND FILLERS ON ELASTOMER PROPERTIES

If a compatible oil is added to an elastomer, the effect is the plasticization of the elastomer. This is expressed as the decrease of storage modulus (G') and this effect for natural rubber is shown in Figure 10-1 [2]. The modulus decreases at all frequencies with the increasing amount of plasticizing oil.

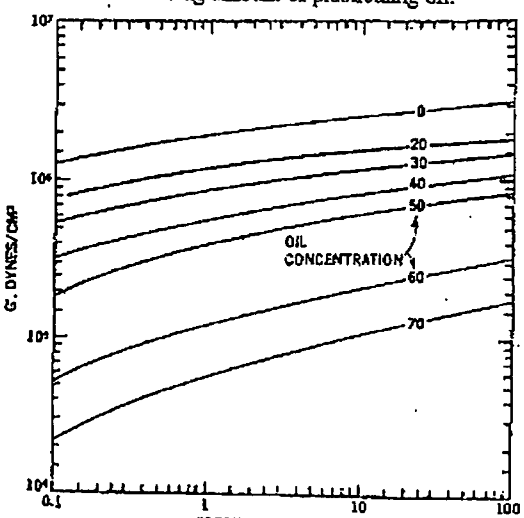

Fig.10-1. Natural rubber/aliphatic oil. G' vs. frequency at 25°C.

Figure 10-2 [2] shows the effect of incompatible polystyrene resin (Piccolastic A75) on the properties of natural rubber. Addition of the resin causes an increase of storage modulus (G') which is consistent with the expected effect of an inert filler.

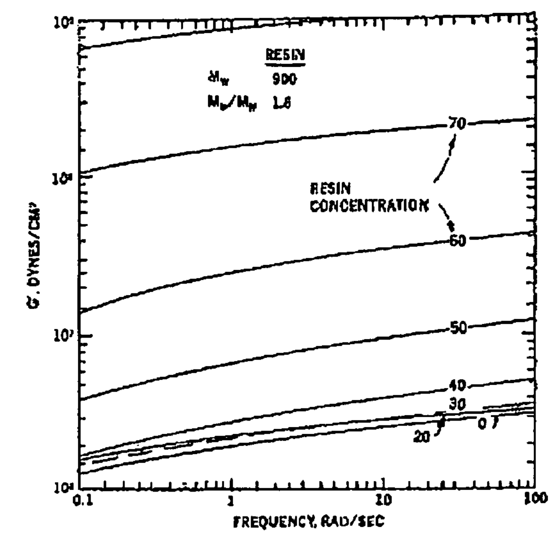

Fig.10-2. Natural rubber/polystyrene resin. G' vs. frequency at 25°C.

EFFECT OF TACKIFYING RESINS ON ELASTOMER PROPERTIES

The effect of a compatible tackifying resin is different from that of a plasticizer or a filler. As shown in Figure 10-3 [2] at low resin concentration (up to 50%) the resin plasticizes the elastomer. At higher concentrations (50-60%) the modulus is decreased at low frequencies, but it is increased at higher frequencies. The resultant adhesive is softer than natural rubber at low frequencies (the frequency range associated with tack) and firmer at high frequencies (the range associated with peel adhesion). This type of behavior is characteristic for pressure sensitive adhesives. Low modulus at low frequency assures a good tack (meets Dahlquist's criterium) and a higher modulus at high frequencies denotes a good peel strength.

The exploration of compatibility with elastomers with various resins by employing dynamic mechanical analysis has been described by Class and Chu [3-5]. Compounding with a compatible resin causes a shift of T_g to the higher values. This is evident from tan δ plot vs temperature as shown in Figure 10-4 [3,4], depicting the effect of a tackifying resin on SBR rubber. The peak of tan δ